Standard of Practice 1: Learn and Apply Rigorous Science, Technology, Engineering, and Mathematics Content	
STEM proficient students will learn and apply rigorous content within Science, Technology, Engineering, and Mathematics (STEM) disciplines to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Demonstrate an understanding of STEM content.	
By the end of Grade 8, Students:	**Instructional Notes and Examples**
Essential Skills and Knowledge • Summarize, explain, and interpret concepts presented in science, technology, engineering, and mathematics courses (see *MSDE science, technology/ engineering, and mathematics standards*). • Describe how scientific, technological, engineering, and mathematics concepts apply to real world situations. • Construct new knowledge from prior knowledge.	First and foremost, STEM education in Maryland is about content. Deep and profound knowledge of science, technology, engineering and mathematics content is critical to a rich STEM program of studies. With a strong content background, STEM students will be able to think logically and abstractly about that content, manipulate that content in new and different ways, and communicate that content to others. The required content is found in each STEM discipline's content standards. According to the National Governors Association 2011 report, *Building a Science, Technology, Engineering, and Math Education Agenda,* helping students see the connections between STEM content and real-world applications is a critical aim of the STEM pipeline. The Maryland Common Core State Curriculum Framework aligns perfectly with the goal of increasing student STEM proficiency because it stresses "not only procedural skill but also conceptual understanding" (Thomasian, 2011). **THE TEACHER** The content teacher possesses not only the content knowledge but also an understanding of its relations to science, technology, engineering, and mathematics content areas. Teaching methodologies reflect high expectations for student achievement of the content standards and promote learning that is relevant, interesting, and meaningful to ALL students. STEM education employs problem/project based and inquiry based pedagogy. To assist with this proficiency, teachers may seek additional resources from http://www.mdk12.org/instruction/curriculum/index.html

THE TEACHER

Suggested Scaffolding for Grade 6 students

- Demonstrate a basic understanding of the engineering design process.
- Describe the four core engineering disciplines: Chemical, Civil, Electrical, and Mechanical.

Suggested Scaffolding for Grade 7 students

- Demonstrate knowledge and skill in using one or more of the steps of the engineering design process.
- Describe engineering disciplines derived from the four core engineering disciplines. (e.g., biomedical engineering, computer engineering, systems engineering)

GLOSSARY TERMS

Prior Knowledge - Information that a student knows before a lesson/ instruction / research / exploration.

Engineering Design Process – It is important to note that there is not one uniform approach to engineering design that is followed by practicing engineers. However, the concepts are similar.

- Identify the problem/product innovation
- Define the criteria/goals
- Research and gather data
- Brainstorm/generate creative ideas
- Analyze potential solutions
- Develop and test models/prototypes
- Select the best solution or design
- Communicate the solution

Standard of Practice 1: Learn and Apply Rigorous Science, Technology, Engineering, and Mathematics Content

STEM proficient students will learn and apply rigorous content within Science, Technology, Engineering, and Mathematics (STEM) disciplines to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.

B. Apply STEM content to develop solutions to problems or construct answers to complex questions.

By the end of Grade 8, Students:	Instructional Resources
Essential Skills and Knowledge • Employ *higher order thinking skills* in the application of content knowledge. • Identify and understand science, technology, engineering, or mathematics content needed to develop answers to complex questions, investigate global issues, or develop solutions to real world problems. • Examine ways science, technology, engineering, or mathematics content knowledge is used to extend human potential.	**GLOSSARY TERMS** **Higher Order Thinking Skills (*HOTS*) -** skills that are employed to engage students in order to strengthen their basic skills and understanding. There are four key thinking skills that are useful for middle school students: to analyze, to compare, to infer, and to evaluate. The following table illustrates how these *HOTS* may be illustrated in three different content areas. (Beyer, 1988)

	Science	Social Studies	Literature
Analyze	Identify the components of process and the features of animate and inanimate objects	Analyze components or elements of an event	Identify components of literary, expository, and persuasive discourse
Compare	Compare the properties of objects or events	Compare causes and effects of separate events	Compare meanings, themes, plots, and reasons
Infer	Draw conclusions; make predictions; pose hypotheses, tests, and explanations	Predict, hypothesize, and conclude	Infer cause and effect
Evaluate	Evaluate soundness and significance of findings	Evaluate credibility of arguments, decisions, and reports; evaluate significance	Evaluate form, believability, significance, completeness, and clarity

Standard of Practice 2: Integrate Science, Technology, Engineering, and Mathematics Content	
STEM proficient students will integrate content from Science, Technology, Engineering, and Mathematics (STEM) disciplines as appropriate to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Analyze interdisciplinary connections that exist within the STEM disciplines and other disciplines.	
By the end of Grade 8, Students:	**Instructional Notes**
<u>Essential Skills and Knowledge</u> • Identify the science, technology, engineering, and mathematics content required to answer complex questions, investigate global issues, and develop solutions for challenges and real world problem • Use graphic organizers (e.g. KWL models, concept maps) to evaluate the interdisciplinary connections between multiple contents required to answer complex questions, develop solutions for real world problems, or investigate global issues. • Draw conclusions between prior knowledge in multiple contents (e.g., ELA, Social Studies, Visual Arts, Physical Education) and the science, mathematics, technology, and engineering related to a complex question, real world problem, or global issue.	Integration is a core belief of STEM education. STEM Education requires the integration of four contents (Science, Technology, Engineering, and Mathematics), as appropriate, to answer complex questions, to investigate global issues, and to develop solutions to real world problems. **THE TEACHER** To assist with content integration, teachers may employ models and resources such as… **KWL-** ○ What do I **KNOW** about the STEM content and its integration with other content relative to the complex question, global issue, or real world problem being explored ○ What do I **WANT** to learn about the STEM content and its integration with other content relative to the complex question, global issue, or real world problem being explored ○ What have I **LEARNED** (accessing prior knowledge) about the STEM content and other content relative to the complex question, global issue, or real world problem being explored **Concept Maps** can be used to show relationships among content related to the complex question, global issue, or real world problem being explored. **UDL – Universal Design for Learning** To facilitate comprehension of the integrated STEM content, teachers should consider

	○ activating prior knowledge of multiple STEM contents ○ bridging concepts with relevant analogies and metaphors ○ highlighting patterns, critical features, big ideas, and relationships http://www.udlwheel.mdonlinegrants.org/ **THE STUDENT** Suggested Scaffolding for Grade 6-7 students: • Propose connections as to how multiple contents (e.g.: ELA, Social Studies, Visual Arts, Physical Education) could be integrated with STEM content to answer complex questions, investigate global issues, and to develop solutions for challenges and real world problems. Examples that demonstrate what students should be able to do: • A student identifies the chemistry concepts related to metalworking and etching (Art). • A student identifies the connection between leavening agents and chemical reactions and their importance in constructing a recipe (Family & Consumer Science). • A student identifies the knowledge of physics that is associated with the design of sporting equipment (Physical Education). • A student identifies the science, technology, engineering, and mathematics content relevant to the real-world problem of obesity among adolescents. ○ Science – Biology, human body systems ○ Technology – technology increases sedentary lifestyle of adolescents ○ Engineering – designing devices that monitor personal health (heart monitors, pedometers) ○ Mathematics – data analysis, data collection

Standard of Practice 2: Integrate Science, Technology, Engineering, and Mathematics Content	
STEM proficient students will integrate content from Science, Technology, Engineering, and Mathematics (STEM) disciplines as appropriate to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
B. Apply integrated STEM content to develop solutions to problems or construct answers to complex questions.	
By the end of Grade 8, Students:	**Instructional Notes:**
<u>Essential Skills and Knowledge</u> • Synthesize and employ content knowledge from science, technology, engineering, mathematics, and other disciplines necessary to generate resolutions to global issues, solutions to real world problems, and/or answers to complex questions. • Evaluate whether the appropriate disciplines were applied in addressing the global issue, real world problem, or complex question.	**THE STUDENT** Suggested Scaffolding for Grade 6-7 students: • Identify and apply content knowledge from science, technology, engineering, mathematics, and other disciplines necessary to generate resolutions to global issues, solutions to real world problems, and/or answers to complex questions.

Standard of Practice 3: Interpret and Communicate Information from Science, Technology, Engineering, and Mathematics	
STEM proficient students will interpret and communicate information from Science, Technology, Engineering, and Mathematics (STEM) to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Identify, analyze, and synthesize appropriate STEM information (text, visual, audio, etc.)	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Identify and select the necessary information from science, technology, engineering, and mathematics to answer a complex question, investigate a global issue, or develop solutions to real world problems. • Paraphrase to state or compose an unbiased summary that includes a central idea and tracks its development throughout a range of diverse science, technology, engineering, and mathematical sources related to the exploration of a complex question, real world problem, or global issue (*See CCSS RI.6-8.2*). • Create new understandings from a range of diverse science, technology, engineering, and mathematics sources related to the exploration of a complex question, real world problem, or global issue.	This standard of practice is aligned to the Maryland Common Core State Curriculum Framework for English Language Arts and the Literacy Standards in Science and Technical Subjects. This proficiency addresses the important skill of synthesizing Science, Technology, Engineering, and Mathematics information to effectively communicate STEM information to diverse audiences. Unique to STEM education is the *required skill* of synthesizing multiple and diverse STEM related information. By grade eight, students will progress in skill from identifying, to analyzing, to synthesizing STEM information necessary for the exploration of a complex question, global issue, or real world problem. **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from http://www.mdk12.org/share/frameworks/CCSC_Reading_Informational_Text_gr6-8.pdf **Six Facets of Understanding** (McTighe & Wiggins, 1999) As students create new understandings from a range of diverse STEM sources, teachers check for student understanding by employing these six facets. When one truly understands, one ○ Can explain ○ Can interpret (tell meaningful stories, offer apt translations) ○ Can apply ○ Have perspective (see diverse points of view)

	○ Can empathize (find value) ○ Have self-knowledge (aware of what one does not understand) Strategies for building understanding of informational text: • **Anticipation Guide/Prediction Guide** – used to activate and assess student's prior knowledge, to focus reading, and to motivate reluctant readers by stimulating their interest in the topic (Billmeyer & Barton, 1998). http://www.readingrockets.org/strategies/anticipation_guide/ • **Pairs Read** – students help each other increase their knowledge and understanding of the text by reading the text aloud to each other (Billmeyer & Barton, 1998). http://www.readingrockets.org/strategies/paired_reading/ **GLOSSARY TERMS** **Communication** - Ability to analyze the audience and convey information with clarity and effectiveness. (McCarthy, 2000)

Standard of Practice 3: Interpret and Communicate Information from Science, Technology, Engineering, and Mathematics	
STEM proficient students will interpret and communicate information from Science, Technology, Engineering, and Mathematics (STEM) to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
B. Apply appropriate domain specific vocabulary when responding to and discussing STEM content.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Identify and define domain-specific vocabulary related to a complex question, global issue, challenge or real world problem. • Determine the meaning of symbols, Glossary Terms, and other domain-specific words and phrases as they are used in specific scientific or technical contexts (CCSS RST.6-8.4). • Select and use the appropriate domain-specific vocabulary when communicating to a particular audience. (e.g.: use of technical language, mathematical symbols) • Use appropriate academic or domain specific words when drawing inferences from a range of science, technology, engineering, and mathematics content. (adapted from CCSS RI1. 8.1)	This proficiency addresses knowledge and skill development related to domain specific vocabulary. Critical to STEM education is the understanding of specific vocabulary used in Science, Technology, Engineering, and Mathematics content areas and how this vocabulary connects across disciplines. By eighth grade, students will be able to distinguish between domain specific vocabulary found in multiple content areas and select/use the appropriate vocabulary when communicating to a particular audience. **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from http://www.mdk12.org/share/frameworks/CCSC_Language_gr6-8.pdf Suggested strategies for student vocabulary development: • **Semantic Feature Analysis** – helps students discern a term's meaning by comparing its features to those of other terms that fall into the same category or class (Billmeyer & Barton, 1998). http://edweb.sdsu.edu/triton/guides/sfa.html • **Stephens Vocabulary Elaboration Strategy (SVES)** – illustrates how vocabulary meanings can vary in different social contexts, content areas, and time periods. Students maintain a "living" vocabulary notebook in which they record unfamiliar terms, their definitions, and a description of each term's usage and meaning every time they encounter it. http://www.justreadnow.com/strategies/sves.htm

	GLOSSARY TERMS **Domain Specific Vocabulary** – the terminology of a specific field of knowledge or content. **Mathematical Symbols** – used to express relationships, quantities, or application in a mathematical representation. **Technical language** – includes the use of terminology specific to technical careers and employs active voice. **Inferences** – a logical guess based on evidence and prior knowledge.

Standard of Practice 3: Interpret and Communicate Information from Science, Technology, Engineering, and Mathematics	
STEM proficient students will interpret and communicate information from Science, Technology, Engineering, and Mathematics (STEM) to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
C. Engage in critical reading and writing of technical information.	
By the end of Grade 8, Students:	**Instructional Notes:**

Essential Skills and Knowledge
• Demonstrate comprehension of STEM related text related to answering a complex question, investigating a global issue, or developing solutions to real world problem. (e.g.: explain the central ideas, drawing inferences, drawing conclusions, verifying or adjusting predictions, make new predictions, paraphrasing and summarizing) (adapted from CCSS RI.6-8.1).
• Among multiple pieces of evidence determine, select, and state the piece of evidence that confirms the meaning of technical information (adapted from CCSS RI.6-8.1).
• Use an objective tone and clarity of information when composing technical writings.
• Compose technical writings (e.g.: include graphics, block style paragraphs, precise-informative headings, numbering for sequential texts, and bullets to identify
	Written and oral communication are critical to the success of a STEM professional. This proficiency addresses knowledge and skill development related to critical reading and writing of technical information. Unique to STEM Education is the development of knowledge and skills in technical writing.
	
	THE TEACHER
	To assist with this proficiency, teachers may seek additional resources from http://web.mit.edu/me-ugoffice/communication/technical-writing.pdf
	
	Suggested strategies for student critical reading development:
	• **SQ3R (Survey, Question, Read, Recite, Review)** – students preview the text material to develop predictions and to set a purpose for reading by generating questions about the topic; they read actively, searching for answers to those questions; they monitor their comprehension as they summarize; and they evaluate their comprehension as they summarize; and they evaluate their comprehension through review activities (Billmeyer & Barton, 1998). http://www.studygs.net/texred2.htm
	
	• **SEARCH Strategy (Select, Establish, Ask, Read, Come, Have)** - used when students are asked to research a topic. The project should focus on a question to be answered rather than on a general topic (Billmeyer & Barton, 1998).
	  ○ Select a topic
	  ○ Establish what students know, think they know, and want to know about the topic
	  ○ Ask questions to raise curiosity

options) that include evidence, appropriate vocabulary and structure applicable for the identified purpose and audience.

- Apply the revision and editing stages of the writing process with an aim to eliminate vague language and repetition (e.g.: reduce phrases and overworked modifiers like “really” and “very”) (adapted from *CCSS W.6-8.1.e*).

  - Read resource material to verify what they know, think they know, to answer questions, to raise new questions
  - Come together to share and review
  - Have group discussions to identify unanswered questions needing further research

THE STUDENT

Suggested Scaffolding for Grade 6-7 students:

- Understand that technical writing uses an objective, not subjective tone.
- Describe technical information with exactness and clarity.

GLOSSARY TERMS

Technical writing – written communication used in specialized careers, specifically careers related to science, technology, engineering, and mathematics.

Writing Process – a systematic approach to writing that includes prewriting, drafting, revising (rewriting), editing, and publishing steps.

Standard of Practice 3: Interpret and Communicate Information from Science, Technology, Engineering, and Mathematics	
STEM proficient students will interpret and communicate information from Science, Technology, Engineering, and Mathematics (STEM) to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
D. Evaluate and integrate multiple sources of information (e.g.: quantitative data, video, and multimedia) presented in diverse formats.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Identify the components of multiple diverse (print, non-print, digital, etc.) STEM sources of information (references) to include: Author, Date of Publication, Edition/Revision, Publisher, intended audience, objective tone, primary or secondary source, and validation by other reliable sources. • Summarize, compare, draw conclusions about, and synthesize significant ideas found in print and non-print texts, including digital media (*CCSS RI.6-7.2*). • Assess the value of one medium versus another for the presentation of a specific topic related to the exploration of a complex question, global issue, or real world problem (adapted from *CCSS RI.8.7*). • Organize and use informational sources from diverse media and formats to help answer complex questions, develop	The key to this proficiency is the integration of multiple diverse resources. "Students report relationships and patterns in data, distinguish between correlation and causation, and compare and contrast independent sets of data for consistency and confirmation of an explanation or solution" (Bybee, 2011). By grade 8, students should evaluate resources from not only one content area but from diverse content areas as related to the exploration of a complex question, global issue, or real world problem. The multiple diverse resources should be related to Science, Technology, Engineering, and Mathematics as well as other content areas required to further understand a complex question, global issue, or real world problem. **THE STUDENT** Suggested Scaffolding for Grade 6 students: • Understand that sources of technical information must be evaluated for accuracy. • Differentiate between quantitative and qualitative data. Suggested Scaffolding for Grade 7 students: • Understand bias and validity of multiple STEM sources of information. • Draw conclusions from the identified STEM information to help answer complex questions, investigate global issues, and to develop solutions for challenges and real world problems. • Apply and justify the use of quantitative and qualitative data when

solutions for real world problems, or investigate global issues (adapted from *CCSS RI.6-8.7*).	communicating STEM information. **GLOSSARY TERMS** **Objective Tone** – an unbiased and unemotional attitude that a writer conveys to the reader. **Primary Source** – a direct source of information not expressed by third party. **Secondary Source**- sources that use and analyze information from other sources such as summaries, interpretations, and evaluations to extend or refine thinking. **Quantitative** – describing, interpreting, or making sense of an observable fact or event based on numerical interpretations. **Qualitative** – describing, interpreting, or making sense of an observable fact or event based on individual interpretation.

Standard of Practice 3: Interpret and Communicate Information from Science, Technology, Engineering, and Mathematics	
STEM proficient students will interpret and communicate information from Science, Technology, Engineering, and Mathematics (STEM) to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
E. Develop an evidence-based opinion or argument.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Introduce a claim(s) about a topic or issue, acknowledge and distinguish the claim(s) from alternate or opposing claims, and organize the reasons and evidence logically (CCSS WHST.6-8.1a). • Support claims(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources (CCSS WHST.6-8.1b). • Use words, phrases, and clauses to clarify the relationships between claims, counterclaims, and reasons from a range of diverse science, technology, engineering, and mathematical sources related to the exploration of a complex question, real world problem, or global issue (adapted from CCSS RI.7-8.6). • Identify ambiguous claims or arguments related to a complex question or real	This proficiency addresses key critical thinking skills related to interpreting and communicating STEM information. "The aim for students is to learn how to use evidence to formulate a logically coherent explanation of phenomena and to support a proposed solution for an engineering problem" (Bybee, 2011). STEM proficient students employ critical thinking skills such as recognizing underlying assumptions, scrutinizing arguments, and deriving evidence-based opinions and arguments from multiples and diverse sources of information to assist them in exploring STEM related complex questions, global issues, or real world problems. **THE TEACHER** Suggested strategies: • **Creative Debate** - promotes debate, creative thinking, and thinking from different perspectives (Billmeyer & Barton, 1998). http://www.justreadnow.com/strategies/debate.htm • **Scored Discussion** – gives students the opportunity to practice and evaluate effective discussion skills. A small group of students carry on a content-related discussion while the teacher and the rest of the class score individual contributions to the discussion. Students are awarded points for contributing relevant information, using evidence, asking clarifying questions, making analogies, and encouraging other group members to participate. (Billmeyer & Barton, 1998) http://www.streetlaw.org/en/landmark/teaching_strategies/scored_discusssion

world problem. • Design and use a decision analysis model (e.g.: decision matrices, decision trees, SWOT, Pareto chart) to identify, clearly represent, and formally assess important aspects of an evidence-based argument. • Cite specific data and sources to support an evidence-based argument.	STEM proficient students employ a variety of decision analysis models to develop evidence-based opinions and arguments. Some models include: • **Decision Trees** http://www.syque.com/quality_tools/toolbook/Decision/decision.htm • **Force Field Diagram** http://www.syque.com/quality_tools/toolbook/Force/when.htm **THE STUDENT** Suggested Scaffolding for Grade 6 students: • Distinguish between subjective and objective information, claims or reasons related to a complex question, global issue, or real world problem. • Understand that STEM professionals use a variety of models to develop evidence-based decisions in such areas as research, technical product design, or engineering. Suggested Scaffolding for Grade 7 students: • Distinguish relevant from irrelevant information, claims, or reasons related to a complex question, global issue, or real world problem. **GLOSSARY TERMS** **Claims –** a statement or thesis which is presented in a way that another person could reasonably disagree; therefore claims can be "proven" only by providing opinion and/or research for support. **Evidence –** facts, figures, details, quotations, or other sources of data and information that provide support for claims or an analysis and that can be evaluated by others; should appear in a form and be derived from a source widely accepted as appropriate to a particular discipline. **Argument** – a purpose for writing or analysis using reasons or evidence to support a claim or opinion.

Standard of Practice 3: Interpret and Communicate Information from Science, Technology, Engineering, and Mathematics	
STEM proficient students will interpret and communicate information from Science, Technology, Engineering, and Mathematics to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
F. Communicate effectively and precisely with others.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Select and use an appropriate model to represent the STEM concepts related to a complex question or real world problem being explored (e.g.: mathematical models, prototypes, simulations). • Use a variety of current communication tools (e.g.: e-mail, discussion boards, portfolios, online surveys, collaborative data collection tools) to gather information, share ideas, and respond to complex questions (MTLSS 4.A.1.a). • Identify the main ideas under discussion and apply higher order questions that yield a deeper analysis of those ideas (CCSS.SL6-8.1a). • Conduct focused research as necessary to prepare for discussions (CCSS.SL6-8.1a). • Access prior knowledge to extend the topic under discussion. (CCSS.SL6-	Communication is one of the 4C's, as defined by the Partnership for 21st Century Skills (http://www.p21.org/), which are essential for success in school, work and life. This proficiency addresses the development of the essential skill of communicating STEM information. **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from http://www.mdk12.org/share/frameworks/CCSC_Speaking_Listening_gr6-8.pdf http://www.p21.org/overview/skills-framework/261 Higher Order Questions: **GLOSSARY TERMS** **Mathematical models** –an abstract representation that uses mathematical language (symbols, relationships) to describe the behavior of a system. **Prototypes** – early models constructed to test a concept or process or to communicate a potential design. **Simulations** – a representation of real-world processes or systems over time. **Higher Order Questions** – questions that require students to go beyond simple recall and engage in more sophisticated thinking. "Teachers who ask "higher order" questions promote learning because these types of questions require students to apply, analyze, synthesize, and evaluate information instead or simply recalling facts"

8.1a). • Adopt the behaviors of effective speakers as appropriate to task, purpose, and audience (CCSS.SL.6-8.4).	(Maryland State Department of Education, Division of Instruction, 1991).

Standard of Practice 4: Engage in Inquiry	
STEM proficient students will engage in inquiry to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Ask questions to identify and define global issues, challenges, and real world problems.	
By the end of Grade 8, Students:	**Instructional Notes:**

Essential Skills and Knowledge
 	
• Dissect a real world problem, challenge, or global issue into smaller pieces to identify the essential components.
• Develop factual questions to define essential components related to the global issue, challenge, or real world problem.
• Develop researchable questions to:
  ○ identify, define, and clarify all parts of a real world problem challenge, or global issue.
  ○ probe the assumptions related to a real world problem, challenge, or global issue.
  ○ probe implications and consequences of solutions to real world problems, challenges, or global issues.
• Refine researchable questions as necessary to further identify and clarify a real world problem, challenge, or
	This standard of practice does not represent a comprehensive inquiry model, but rather a focus on design, formulation and refinement of questions. This is not a sequential, linear process, but more cyclical in nature.
	
	THE TEACHER
	The teacher and students share responsibility for posing higher level thinking questions engaging in authentic dialogue. The dialogue reflects student engagement in making inferences, developing hypotheses, synthesizing understandings, considering possibilities, and making connections to prior learning and other content areas. The teacher encourages students to identify meaningful questions, issues, and problems to be solved (*DODEA Quality Indicator Map*).
	
	To assist with this proficiency, teachers may seek additional resources regarding inquiry from:
	http://www.youthlearn.org/learning/planning/lesson-planning/how-inquiry/how-inquiry
	http://www.thirteen.org/edonline/concept2class/inquiry/
	http://www.engin.umich.edu/~cre/probsolv/strategy/cthinking.htm
	http://www.youthlearn.org/sites/youthlearn.org/files/images/1-1-1_1.gif
	http://www.youthlearn.org/sites/youthlearn.org/files/images/1-1-1_2.gif
	http://www.youthlearn.org/sites/youthlearn.org/files/images/1-1-1_3.gif
	
	THE STUDENT
	Students will independently find and use a variety of sources of information (refer to MSSOP 3) and ideas to increase their understanding of a complex question, global

global issue being explored.	issue, or real world problem. They will ask relevant questions such as: • What do I know about the topic? • What do I want to know? • How do I find out more about the topic? • What did I learn? • How do I use what I learned? • What are the constraints? Suggested Scaffolding for Grade 6 - 7 students: • Use prior knowledge to individually formulate and refine questions to meet an information need. *(SLM 6-8 1.B.3.a)* • With guidance, generate effective criteria for observations and questions for interviews and surveys. *(SLM 6-8 3.B.1.a)* • Distinguish between the two types of inquiry questions: factual and researchable. • Understand that researchable questions generate many factual questions. • Use background information to refine researchable questions. *(SLM 6-8 1.B.3.b)* Example that demonstrate how students can refine researchable questions with factual questions: • The researchable question, "*Why are people concerned about deforestation?*" can be refined by more factual level questions such as, "*What are the drawbacks of deforestation? What does deforestation affect? How does it affect air quality? Temperatures?*" **GLOSSARY TERMS** **Researchable Questions** – questions that are not answerable with finality in a brief sentence. Typically, further research is required to answer overarching questions. Their aim is to stimulate thought, to provoke inquiry, and to spark more questions.

	Factual Questions – questions that are derived from overarching questions. These are the "What is…" questions. Their answers are absolute and are usually singular (only one right answer).

Standard of Practice 4: Engage in Inquiry	
STEM proficient students will engage in inquiry to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
B. Conduct research to refine questions and develop new questions.	
By the end of Grade 8, Students:	**Instructional Notes:**

Essential Skills and Knowledge
 	
• Investigate and research information from primary and secondary sources to answer factual and researchable questions.
• Use accurate records or logs to evaluate if evidence-based answers to factual and researchable questions
  ○ help or support the question?
  ○ inspire/suggest the development of new questions?
• Reflect on and refine research questions, theses, hypotheses, or positions based on new information discovered in the inquiry process. *(SLM 6-8 3.C.3.a)*
	THE TEACHER
	To assist with this proficiency, teachers may refer to the Maryland State Department of Education School Library Media State Curriculum which supports a process of interacting with information (locating, collecting, organizing, interpreting and sharing). http://www.mdk12.org/share/vsc/vsc_librarymedia_grpk8.pdf
	
	In addition, teachers may seek simple planning templates that help students identify and refine questions:
	http://www.youthlearn.org/sites/youthlearn.org/files/images/1-1-1_5.gif
	http://www.youthlearn.org/sites/youthlearn.org/files/images/1-1-1_6.gif
	http://www.youthlearn.org/sites/youthlearn.org/files/images/1-1-1_7.gif
	
	THE STUDENT
	Suggested Scaffolding for Grade 6 - 7 students:
	• Create a list of resources (e.g.: Internet, informational text, multimedia tools) necessary to answer the factual and researchable questions related to a real world problem or global issue being explored.
	• Create a list of keywords for research.
	• Use keywords and text features to find information within a specific source. *(SLM 6-8 3.A.1.a)*
	• Keep accurate records or logs to be used when compiling information.
	• Apply safe practices for both assignment-related and personal online searches.

	(SLM 6-8 2.A.2.b) **GLOSSARY TERMS** **Researchable Questions** – questions that are not answerable with finality in a brief sentence. Typically, further research is required to answer overarching questions. Their aim is to stimulate thought, to provoke inquiry, and to spark more questions. **Factual Questions** – questions that are derived from overarching questions. These are the "What is…" questions. Their answers are absolute and are usually singular (only one right answer).

Standard of Practice 5: Engage in Logical Reasoning	
STEM proficient students will engage in logical reasoning to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Engage in critical thinking.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Break down a complex question, challenge, problem or global issue into parts to discover its nature and relationships. • Identify and employ a line of reasoning (e.g.: deductive, inductive, analogical, cause/effect, conditional) to answer complex questions, investigate global issues, and develop solutions for challenges and real world problems. • Employ critical thinking strategies (e.g.: problem solving, decision making, conceptualizing) to answer complex questions, investigate global issues, and develop solutions for challenges and real world problems. • Reflect on one's assumptions and thinking, for the purpose of gaining a deeper understanding of a complex question, global issue, or real world problem.	This proficiency addresses the skill of critical thinking. "Critical Thinking is one of the most abused terms in our thinking skills vocabulary. It is more than engaging in logical thinking strategies such as problem solving and decision making. In sum, critical thinking is essentially evaluative in nature. It involves precise, persistent, and objective analysis of any claim, source, or belief to judge its accuracy, validity, or worth. For instance, one can search for bias, distinguish statements of fact from value judgments, and identify logical fallacies without engaging in any of the previously stated commonly used logical thinking strategies" (Beyer, 1988). **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from http://changingminds.org/disciplines/argument/types_reasoning/types_reasoning.htm http://www.engin.umich.edu/~problemsolving/strategy/crit-n-creat.htm **THE STUDENT** Suggested Scaffolding for Grade 6 – 7 students: • Experiment with problem solving critical thinking strategies that include: recognizing a problem, representing the problem, choosing a solution plan, executing the plan, and evaluating the solution. • Experiment with decision making critical thinking strategies that include: defining the goal, indentifying alternatives, analyzing alternatives, ranking alternatives, judging highest-ranked alternatives, and choosing "best" alternatives. • Experiment with conceptualizing critical thinking strategies that include:

identifying examples, clarifying assumptions, identifying common attributes, and classifying attributes.

GLOSSARY TERMS

Deductive Reasoning - A logical reasoning operation where one moves from general principles to specifics.
http://changingminds.org/disciplines/argument/types_reasoning/deduction.htm

Inductive Reasoning – A logical reasoning operation where one draws inferences from observations in order to make generalizations.
http://changingminds.org/disciplines/argument/types_reasoning/induction.htm

Analogical Reasoning - A logical reasoning operation used in making relationships between known and unknown information.
http://changingminds.org/disciplines/argument/types_reasoning/analogical_reasoning.htm

Cause and Effect – A logical reasoning operation where one identifies the relationships between actions or events such that one or more are the result of other or others. http://changingminds.org/disciplines/argument/types_reasoning/cause-and-effect.htm

Problem Solving Critical Thinking Strategy - a critical thinking strategy whose steps include

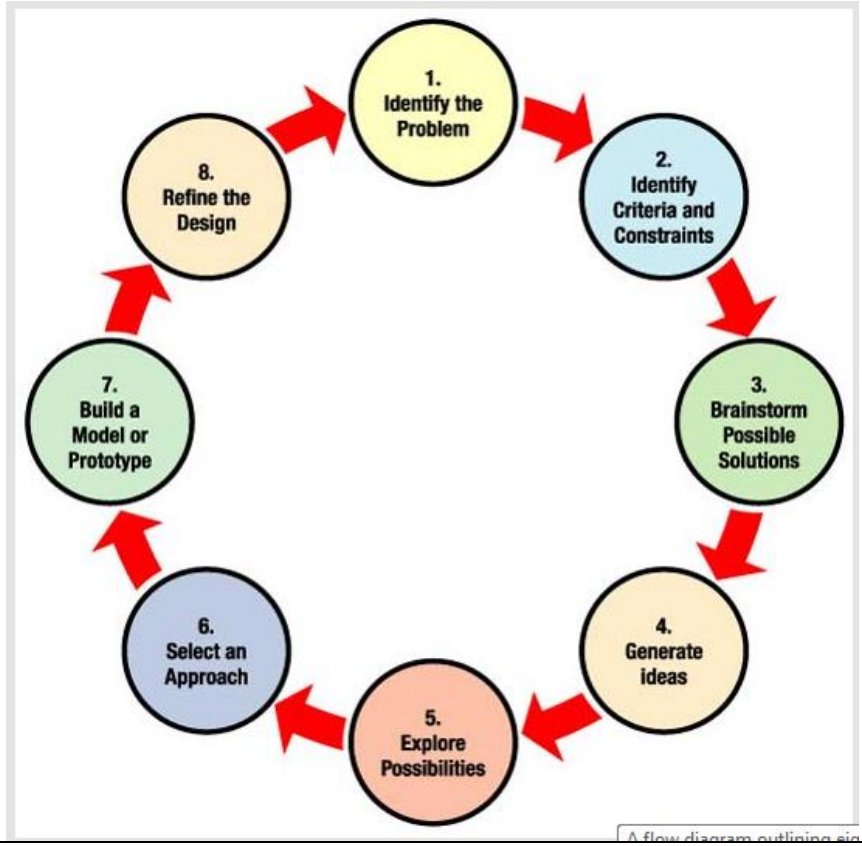
- Recognize a problem
- Represent the problem
- Devise/Choose a solution plan
- Execute the plan
- Evaluate the solution (Beyer, 1988)

Decision Making – a critical thinking strategy whose steps include

- Define the goal
- Identify alternatives

	○ Analyze alternatives ○ Rank alternatives ○ Judge highest-ranked alternatives ○ Choose "best" alternative (Beyer, 1988) **Conceptualizing –** "It results in putting new ideas together, discovering insights that help define problems, and creating theoretical models to explain things" (Oaks, Leone, & Gunn, 2006). Steps include ○ Identify examples ○ Identify common attributes ○ Classify attributes ○ Interrelate categories of attributes ○ Identify additional examples/non-examples ○ Modify concept attributes/structure (Beyer, 1988) **Conditional Reasoning** – based on an 'if A then B' construct that posits B to be true if A is true. http://changingminds.org/disciplines/argument/types_reasoning/conditional_reasoning.htm

Standard of Practice 5: Engage in Logical Reasoning	
STEM proficient students will engage in logical reasoning to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
B. Evaluate, select, and apply appropriate systematic approaches (scientific & engineering process, engineering design process, and/or mathematical practices).	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Define and differentiate between systematic and intuitive approaches. • Understand the iterative nature of systematic approaches. • Justify how systematic approaches can be combined. • Identify a systematic approach (e.g.: engineering design process, *Scientific and Engineering Practices*, computer programming methodology, *Standards for Mathematical Practices*) used to develop solutions to problems or challenges, construct answers to complex questions, or investigate global issues. • Compare and contrast systematic approaches to develop solutions to problems or challenges, construct answers to complex questions, or investigate global issues.	STEM professionals answer complex questions, investigate global issues and develop solutions to a very wide variety of problems. "To maximize the creative problem-solving process, a systematic approach is recommended" (Oaks, Leone, & Gunn, 2006). STEM proficient students will develop skills and knowledge in systematic approaches. Students focus on answering the following five questions as they employ systematic approaches. • What is wrong? • What do we know? • What is the real problem? • What is the best solution? • How do we implement the solution? **GLOSSARY TERMS** **Intuitive Approach to problem solving –** using or based on what one feels to be true even without reasoning; acting on instincts **Systematic Approach to problem solving –** performed, disposed or acting in a methodical way to reach a resolution to a problem. **Iterative –** the act of repeating a process usually with the aim of approaching a desired goal or target or result. **Scientific Method –** an analytical problem solving methods whose steps include • Define the problem or issue

• Select and use the appropriate systematic approach(es) throughout the process of answering complex questions, investigating global issues, and developing solutions to real world problem.	• Gather the facts • Develop a hypothesis • Perform a test • Evaluate the results **Engineering Design Process** – It is important to note that there is not one uniform approach to engineering design that is followed by practicing engineers. However, the concepts are similar. Example: http://www.nasa.gov/audience/foreducators/plantgrowth/reference/Eng_Design_5-12.html 

Standard of Practice 5: Engage in Logical Reasoning	
STEM proficient students will engage in logical reasoning to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
C. Apply Science, Technology, Engineering, and Math content to construct creative and innovative ideas.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Understand that STEM professionals employ creativity and imagination as they construct creative ideas and develop innovative solutions to complex questions and real world problems. • Utilize brainstorming strategies to creatively solve real world problems, answer complex questions, or investigate global issues. • Create visual images or forms from observation, memory, and imagination to convey ideas and personal meaning relative to the exploration of a complex question or a real world problem (e.g.: prototypes, technical drawings, artistic expressions) (*Visual Arts 3.1.c*).	Logical reasoning requires teachers and students to employ creativity and innovation. Creativity in instructional design allows for increased student engagement. Students should be more creative and imaginative as they try to solve real world problems, explore solutions to complex questions, and investigate global issues. Learning how to visualize new and unfamiliar information is important in science, technology, engineering, and mathematics. Visualization can be learned and developed with practice. The solution to most problems begins with an imagined idea or concept. (Oaks, Leone, & Gunn, 2006) **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from: http://www.syque.com/quality_tools/toolbook/Brainstorm/brainstorm.htm http://www.mdk12.org/instruction/curriculum/visual_arts/standard3/grade8.html **THE STUDENT** Suggested Scaffolding for Grade 6 students: • Compare and contrast common innovative products to non-innovative products to illustrate what makes some products creative and innovative. • Interpret visual representation (e.g.: simulations, models) of ideas and meanings relative to the exploration of a complex question or a real world problem. Suggested Scaffolding for Grade 7 students: • Redesign an engineered product in different ways to improve its productivity or

appeal to different customers.

- Practice using visual images or forms from observation, memory and imagination (e.g.: developing analogies, breaking down a problem and regrouping, the "What if" strategy) to creatively solve real world problems, answer complex questions, or investigated global issues.
- Develop creative problem statements for real world problems.

GLOSSARY TERMS

Brainstorming – a technique used to stimulate as many innovative solutions as possible. The goal is to stimulate your mind to trigger concepts or ideas that systematic problem solving might miss. (Oaks, Leone, & Gunn, 2006)

- Pick a facilitator
- Define the problem
- Explain the process
- Record all ideas
- Involve every team member
- No evaluating
- Eliminate duplicates
- Vote on or Prioritize ideas

Problem Statement – a critical component of defining a problem or issue. It involves restating the problem or issue in your own words in order to clarify it and determine which criteria the solution must meet, and which constraints limit what is possible. "For example, suppose someone were to say to an engineering team, 'You should do something about all the garbage produced in our community.' Although the statement names a real problem, it is too general and vague. Is the person suggesting that the engineers design ways of removing garbage, or ways to reuse the garbage, or products that create less garbage, or combination of all three?" (Brusic, Fales, & Kuetemeyer, 2008)

Standard of Practice 5: Engage in Logical Reasoning	
STEM proficient students will engage in logical reasoning to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
D. Analyze the impact of global issues and problems at the local, state, national, and international levels.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Describe the global issues in terms of the societal, environmental, political, economical, and ethical impacts on the local community. • Explain the global constraints on a creative answer or solution to a complex question, challenge, or real world problem. • Develop creative answers or solutions, which make allowances for global constraints, to complex questions or real world problems.	**THE STUDENT** Suggested Scaffolding for Grade 6 - 7 students: • Identify global issues that impact the local community. • Explain the STEM relevance of a global issue.

Standard of Practice 6: Collaborate as a STEM team	
STEM proficient students will collaborate as a STEM team to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Identify, analyze, and perform a STEM specific SUBJECT MATTER EXPERT role.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Determine the STEM team's goal within the context of answering a complex question, investigating a global issue, or developing solutions for challenges or real world problems. • Identify individual knowledge and skills that are beneficial to reaching the STEM team's goal. • Identify the subject matter experts needed to accomplish the STEM team's goal. • Apply the knowledge and skills related to the duties of the assigned or selected subject matter expert role within a STEM team. • Demonstrate knowledge and skills of multiple subject matter expert roles.	This standard of practice addresses the important 21st Century skill of collaboration. Collaboration is one of the 4C's, as defined by the Partnership for 21st Century Skills (http://www.p21.org/), which are essential for success in school, work and life. Middle school students practice effective collaboration when they assume shared responsibility for collaborative work, and value the individual contributions made by each team member. STEM requires teams, which is different from groups, to answer complex questions, investigate global issues and develop solutions for challenges or real world problems. "The term group implies little more than several individuals in some proximity to one another. The term team, on the other hand, implies two or more persons who work together to achieve a common purpose" (Gomez, Oakes, & Leone, 2007). STEM teams require collaboration between subject matter experts. **THE STUDENT** Suggested Scaffolding for Grade 6 students: • Describe how STEM teams benefit from a variety of people who are experts in various subject matters including those in non-typical STEM fields. Suggested Scaffolding for Grade 7 students: • Determine if an expert from an additional content field is needed in order to reach the team's goal. **GLOSSARY TERMS** **Subject Matter Experts -** A person who is an expert in a particular area or topic.

Standard of Practice 6: Collaborate as a STEM team	
STEM proficient students will collaborate as a STEM team to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
B. Share ideas and work effectively with a STEM focused multidisciplinary team to achieve a common goal.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Demonstrate the ability to accept divergent views and be sensitive to one's biases when sharing ideas and working effectively within a STEM team. • Apply self-monitoring strategies to establish and adjust appropriate tone, body language, and vocabulary when sharing ideas and working effectively within a STEM team (adapted from CCSS SL.6-8.1b). • Perform a team management's role (e.g.: leader, reporter, recorder, etc.) as a contributing member of a STEM team. • Recognize and expand on the work of others. • Identify and resolve conflicts using skills such as consensus, comprise, avoidance, and accommodation (MCDF 6-8 1B.4). • Use constructive criticism when necessary to meet the goals of the	Shared decision making is what makes teams work. Understand all angles, act accordingly, and accept the group decision (McCarthy, 2000). Individual team members of a successful team should have the following attributes: • Attendance • Responsibility – accepts responsibility for tasks and completes tehm on time • Ability – contributes abilities fully to the team's purpose • Creativity – posess creative energy and helps spark the creative efforts of everyone else • Personality – has positive attitudes, encourages others (Gomez, Oakes, & Leone, 2007). **THE TEACHER** The teacher varies the teaming of students according to individual learning needs, interests, and styles. The composition of student teams is dynamic and often reflects student input. Students are actively involved in the groupings, self-monitor their productivity, are individually accountable, and coach each other to meet the established standards (*DODEA Quality Indicator Map*). Collaboration is the ability to team with others (utilize multiple talents) to solve complex problems or to create complex tools, services, and products; will require cooperation, compromise, consensus, and community building. http://www.sygue.com/quality_tools/toolbook/Teamwork/team_roles.htm

team.	**THE STUDENT** Suggested Scaffolding for Grade 6 - 7 students: • Differentiate between management and Subject Matter Expert roles. • Identify the team management roles needed to work effectively within a STEM team. (e.g.: leader, reporter, recorder, etc.) • Effectively communicate the ideas gathered in research to the rest of the group. **GLOSSARY TERMS** **Leader** – one who demonstrates the ability to motivate others to move with enthusiasm toward a goal that is seen with a passion (McCarthy, 2000). Characteristics of a Leader: • They have pride in who they are and what they can do. • They do their work with enthusiasm • They believe that they are engaged in meaningful work • They persevere. • They demonstrate listening skills. • They demonstrate ethical behaviors.

Standard of Practice 6: Collaborate as a STEM team	
STEM proficient students will collaborate as a STEM team to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
C. Listen and be receptive to ideas of others.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Apply critical listening strategies to determine the speaker's argument and claims (e.g.: paraphrasing, clarifying, perception checking, summarizing, empathy) (adapted from *CCSS SL.6-8.3*). • Demonstrate collegiality when asking and responding to questions and comments (*CCSS 6-8 SL.1.c*). • Value and support the contributions of others by paraphrasing or summarizing new information being shared (*CCSS SL.6-8.1c*).	**THE STUDENT** Suggested Scaffolding for Grade 6 - 7 students: • Apply self-monitoring strategies to establish and adjust appropriate tone, body language, and vocabulary. • Actively and constructively participate in the group's discussion.

Standard of Practice 6: Collaborate as a STEM team	
STEM proficient students will collaborate as a STEM team to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
D. Analyze career opportunities that exist in a variety of STEM fields relevant to the STEM team's goal.	
By the end of Grade 8, Students:	**Instructional Notes/Examples :**
Essential Skills and Knowledge • Identify the career that aligns with the subject matter expert role performed in learning activities. • Examine various STEM career opportunities through interviews, informational texts, field trips, etc. as related to the learning activity. • Complete tasks in a simulated STEM work environment related to the learning activities. • Compile artifacts for reflection on STEM careers related to the STEM projects experienced (e.g.: e-portfolio, design notebook). • Develop a high school plan that includes STEM related courses and potential career pathways of study (e.g.: information technology, computer science, and engineering) (adapted from *MCDF 3.A.1, MCDF 3.A.3*).	This proficiency explores many potential, collaborative STEM careers in science, engineering, medicine, information technology, and mathematics. "The main difference between the engineer and the scientist is in the object of each one's work. The scientist searches for answers to technological questions to obtain the knowledge of why a phenomenon occurs. The engineer also searches for answers to technological questions, but always with an application in mind" (Oaks, Leone, & Gunn, 2006). Technologists work with existing technology to produce goods for society. The Accreditation Board for Engineering and Technology (ABET), the national board that establishes accreditation standards for all engineering programs, defines engineering as *"*… the profession in which a knowledge of the mathematical and natural sciences, gained by study, experience, and practice, is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind*"* (Oaks, Leone, & Gunn, 2006). **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from: http://www.pbslearningmedia.org/content/wpsu09-stemcareers.text.lpchoosingSTEMcareer/ http://www.pbslearningmedia.org/content/ean08.sci.ess.earthsys.lpscicareer/ **THE STUDENT** Suggested Scaffolding for Grade 6 - 7 students:

	• Compare and explore two or more STEM careers related to the Subject Matter Expert roles performed in the learning activities. • Describe how STEM careers relate to the needs and functions of Maryland's economy and affect one's career development. (*MCDF 2.A.1b*)

Standard of Practice 7: Apply Technology Strategically	
STEM proficient students will apply technology appropriately to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
A. Identify and understand technologies needed to develop solutions to problems or construct answers to complex questions.	
By the end of Grade 8, Students:	**Instructional Notes:**
<u>Essential Skills and Knowledge</u> • Identify and justify technologies needed to develop solutions to problems or construct answers to complex questions • Select and apply appropriate technologies needed to develop solutions to problems or construct answers to complex questions • Analyze how simple machines and/or other technological tools are used to develop solutions to problems or construct answers to complex questions (e.g., building of the pyramids, trans-continual railroad, & cotton gin). • Use simple machines and/or other technological tools to create new technologies to develop solutions to problems or construct answers to complex questions	This proficiency focuses on technology education which is the study of the human-made world. Technology refers to technical means, products, or procedures that a student employs to develop solutions to problems or construct answers to complex questions. It does not include instructional technology, which refers to technical means, products, or procedures that a teacher employs to deliver content. **THE TEACHER** The teacher supports an environment where technology is used by the student as a tool in support of learning. "Students are able to select the appropriate technology tool for a variety of tasks/projects related to communication, research, design, problem-solving, and creative products" (*DODEA Quality Indicator Map*). **THE STUDENT** Suggested Scaffolding for Grade 6 - 7 students: • Differentiate between technology and engineering. • Identify resources needed to create technology. (e.g.: people, tools, materials, capital, time, energy, information) • Clarify how technology can be simple or complex. (e.g., Nine Core Technologies: electronic, structural, electrical, mechanical, optical, biological, material, fluid, thermal)

Standard of Practice 7: Apply Technology Strategically	
STEM proficient students will apply technology appropriately to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
B. Analyze the limits, risks, and impacts of technology.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Identify and predict the limitations, risks, and impacts of existing technologies. • Analyze the positive and negative effects of technology (e.g.: trade-off analysis, benefit-risk analysis). • Evaluate technology trends and potential effects of technological developments. • Correlate technological advances to advances in science, engineering, and mathematics.	"It is often said that with technology come trade-offs and with each trade-off come risks. When you solve a problem, you also change the original conditions that led to the problem, so you have, in effect, changed the world. Trade-offs are the new problems created when you solved the problem in the first place" (Hutchinson & Karsnitz, 1994). **GLOSSARY TERMS** **Trade-off analysis** - involves looking at cost, safety, economic, and environmental impacts of technology. "For example, for many years fossil fuels, such as coal and oil, have been used to provide heat and power. These were desirable impacts. Then it was discovered that burning these fuels causes air pollution and acid rain. Some power plants release heat into oceans, rivers, and lakes, which damages the water environment" (Brusic, Fales, & Kuetemeyer, 2008). **Benefit-risk analysis** -

Standard of Practice 7: Apply Technology Strategically	
STEM proficient students will apply technology appropriately to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
C. Engage in responsible/ethical use of technology.	
By the end of Grade 8, Students:	**Instructional Notes:**
Essential Skills and Knowledge • Adhere to the safety guidelines, policies, and intended use of technological tools (e.g.: copyright protections, cyber safety and ethics, school and school district technology use policy). *(adapted from SLM 6-8 2.A.2.a)* • Discriminate between responsible and irresponsible uses of technology. • Analyze the consequences of irresponsible use of technology. • Employ the behaviors of a digital citizen.	This proficiency focuses on responsible / ethical use of technology. Many professions have established a "code of ethics" as an attempt to codify certain principles of the profession. For example, the National Society of Professional Engineers (NSPE) established fundamental canons, rules of practice and professional obligations. The preamble of this code of ethics includes the following statement: "Engineers must perform under a standard of professional behavior that requires adherence to the highest principles of ethical conduct." Ethics are moral principles and values that guide conduct. Ethics are important in the development, selection, use of many technologies and when inventors and researchers in technology base their ideas on another's work. To use someone else's invention without permission or without giving credit to the person is unethical and often illegal (Brusic, Fales, & Kuetemeyer, 2008). **THE TEACHER** To assist with this proficiency, teachers may seek additional resources from: http://www.digitalcitizenship.net/Nine_Elements.html http://onguardonline.gov/topics/protect-kids-online **THE STUDENT** The STEM proficient student engages in responsible and ethical use of technology and employ behaviors of a digital citizen. Suggested Scaffolding for Grade 6 - 7 students:

	• Debate responsible and ethical use of technology in the context of solving various problems. • Practice digital etiquette when sharing findings and conclusion. (*SLM 6-8 5.A.2.b)* **GLOSSARY TERMS** **Digital Citizen –** a person who uses technology and the Internet effectively and responsibly. **Digital Etiquette** - the conventional rules of personal behavior pertaining to courteous online practices.

Standard of Practice 7: Apply Technology Strategically	
STEM proficient students will apply technology appropriately to answer complex questions, to investigate global issues, and to develop solutions for challenges and real world problems.	
D. Improve or create new technologies that extend human capability.	
By the end of Grade 8, Students:	**Instructional Notes:**
<u>Essential Skills and Knowledge</u> • Construct a new way to use an existing technology for the exploration of a complex question, global issue, or real world problem. • Recommend ways to improve technological tools. • Design and construct technological tools necessary to answer complex questions, investigate global issues, and develop solutions for challenges and real world problems.	**THE STUDENT** Suggested Scaffolding for Grade 6 - 7 students: • Identify technology that has been improved throughout history. • Evaluate improvements in technology and describe how the improvement extended human capability.

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